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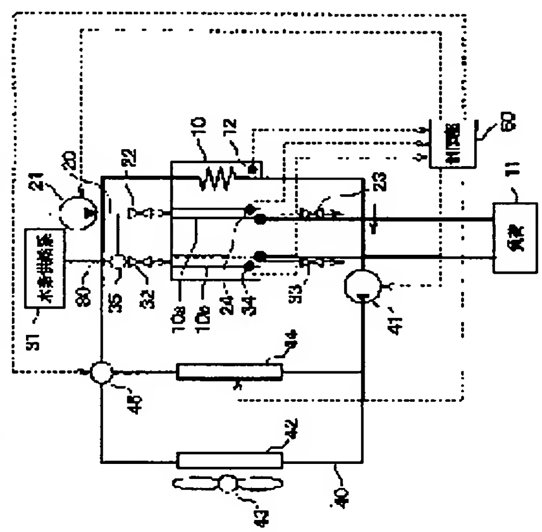
(54) FUEL CELL SYSTEM

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a fuel cell system which is used under a low-temperature environment, capable of removing water inside a fuel cell in a short time, when operation is stopped.
SOLUTION: A cooling water path 40 for circulating cooling water in the fuel cell 10 is provided with cooling parts 42, 43 for cooling cooling water, when normal operation of the fuel cell 10 is performed and a heating part 44 for heating cooling water, when water removing operation is performed; and a flow passage of cooling water is constituted so as to switch to cooling part 42, 43 sides or a heating part 44 side. After normal operation of the fuel cell 10 is ended, prescribed dry air is supplied into an air path 20 and a hydrogen path 30, and the flow passage of cooling water is switched to the heating part 44 side so as to heat the fuel cell 10 up to a prescribed temperature.



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CLAIMS

[Claim(s)]
[Claim 1] The air path which is a fuel cell system equipped with the fuel cell (10) which is made to carry out electrochemical reaction of hydrogen and the oxygen, and obtains power, and the oxygen supplied to said fuel cell (10) passes (20), The hydrogen path which the hydrogen supplied to said fuel cell (10) passes (30), While having a heating means (44) to heat said fuel cell (10) and supplying a predetermined dry gas to said air path (20) and said hydrogen path (30) after the usual shutdown of said fuel cell (10) The fuel cell system characterized by heating said fuel cell (10) to predetermined temperature with said heating means (44).
[Claim 2] Said dry gas is a fuel cell system according to claim 1 characterized by being air.
[Claim 3] The cooling-water-flow path which makes said fuel cell (10) circulate through cooling water (40), It is prepared in said cooling water path (40), and has the cooling section (42 43) which cools said cooling water at the time of usual operation of said fuel cell (10). Said heating means In said cooling water path (40), it is prepared juxtaposition-wise or in serial with said cooling section (42 43). Are the heating unit (44) which heats said cooling water, and the passage of said cooling water is constituted switchable at said said cooling section (42 43) or heating unit (44) side. The fuel cell system according to claim 1 or 2 characterized by changing the passage of said cooling water to said heating unit (44) side in case said fuel cell (10) is heated after usual operation termination of said fuel cell (10).
[Claim 4] Claim 1 characterized by controlling whenever [stoving temperature / of said fuel cell (10) by said heating means (44)] based on the temperature which was equipped with the temperature sensor (12) which detects the temperature of said fuel cell (10), and was detected with said temperature sensor (12) thru/or the fuel cell system of any one publication of three.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention applies [to mobiles, such as a car, a vessel, and a portable electric organ,] about the fuel cell system which consists of a fuel cell which generates electrical energy by the chemical reaction of hydrogen and oxygen and is effective.
[0002]
[Description of the Prior Art] The fuel cell system conventionally equipped with the fuel cell which generates electricity using the electrochemical reaction of hydrogen and oxygen (air) is known. For example, in the polyelectrolyte mold fuel cell considered as driving sources for cars etc., there is a problem that the moisture which exists near the electrode freezes in the state of low temperature 0 degree C or less, and check diffusion of reactant gas or the conductivity of an electrolyte membrane falls.
[0003] In case a fuel cell is started under such a low-temperature environment, by inhibition of advance and attainment of the reactant gas (hydrogen and air) to the blinding or the electrolyte membrane of a reactant gas path by freezing, even if it supplies fuel gas, electrochemical reaction does not advance, but there is a problem that a fuel cell cannot be started. Furthermore, lock out of the gas path by freezing of the moisture which dewed within the reactant gas path is also produced.
[0004] In order to prevent freezing inside a fuel cell and to raise low-temperature starting nature, to remove beforehand the moisture frozen under a low-temperature environment from the interior of a fuel cell is desired. For this reason, it is possible to remove the moisture in a fuel cell by airstream supplying air in a fuel cell.
[0005]
[Problem(s) to be Solved by the Invention] However, when airstream removes the moisture in a fuel cell, heat will be taken by the latent heat of vaporization in the case of moisture evaporation, and the temperature inside a fuel cell will fall. There is a problem that the evaporation of moisture falls and the moisture removal in a fuel cell takes time amount by this.
[0006] This invention aims at offering the fuel cell system the moisture inside a fuel cell can be [a system] removable in a short time in the fuel cell system used under a low-temperature environment in the case of shutdown in view of the above-mentioned trouble.
[0007]
[Means for Solving the Problem] In order to attain the above-mentioned purpose, in invention according to claim 1 The air path which is a fuel cell system equipped with the fuel cell (10) which is made to carry out electrochemical reaction of hydrogen and the oxygen, and obtains power, and the oxygen supplied to a fuel cell (10) passes (20), The hydrogen path which the hydrogen supplied to a fuel cell (10) passes (30), While having a heating means (44) to heat a fuel cell (10) and supplying a predetermined dry gas to an air path (20) and a hydrogen path (30) after the usual shutdown of a fuel cell (10), it is characterized by heating a fuel cell (10) to predetermined temperature with a heating means (44).
[0008] Thus, it can prevent that fuel cell temperature falls to gas supply and coincidence with moisture evaporation by heating a fuel cell (10) at the time of moisture removal operation. By this, evaporation of the residual moisture inside a fuel cell (10) can be promoted, moisture removal inside a fuel cell (10) can be performed in a short time, freezing of a fuel cell can be avoided, and the starting nature of the fuel cell (10) under low temperature can be raised.
[0009] Moreover, in invention according to claim 2, the dry gas is characterized by being air. Thus, moisture removal can be performed by using air, without forming a special gas transfer unit. Moreover, the dry air can be offered by not performing humidification to the air usually performed at the time of operation.

[0010] Moreover, the cooling-water-flow path which makes a fuel cell (10) circulate through cooling water in invention according to claim 3 (40), It is prepared in a cooling water path (40), and has the cooling section (42 43) which cools cooling water at the time of usual operation of a fuel cell (10). A heating means In a cooling water path (40), it is prepared juxtaposition-wise or in serial with the cooling section (42 43). Are the heating unit (44) which heats cooling water, and the passage of cooling water is constituted switchable at the cooling section (42 43) or heating unit (44) side. After usual operation termination of a fuel cell (10), in case a fuel cell (10) is heated, it is characterized by changing the passage of cooling water to a heating unit (44) side.
[0011] By such configuration, the existing fuel cell cooling system can be used and a fuel cell (10) can be heated with the simple configuration which adds the heating unit (44) of cooling water to this.
[0012] Moreover, in invention according to claim 4, it has the temperature sensor (12) which detects the temperature of a fuel cell (10), and is characterized by controlling whenever [stoving temperature / of the fuel cell (10) by the heating means (44)] based on the temperature detected with the temperature sensor (12). It can maintain at the temperature which can evaporate residual water efficiently by this in the range which does not destroy fuel cell temperature for the electrolyte membrane of a fuel cell (10) etc.
[0013] In addition, the sign in the parenthesis of each above-mentioned means shows correspondence relation with the concrete means of a publication to the operation gestalt mentioned later.
[0014]
[Embodiment of the Invention] Hereafter, the operation gestalt of this invention is explained based on drawing 1 and drawing 2 . This operation gestalt applies a fuel cell system to the electric vehicle (fuel cell car) which runs a fuel cell as a power source.
[0015] Drawing 1 shows the whole fuel cell system configuration of this operation gestalt. As shown in drawing 1 , the fuel cell system of this operation gestalt is equipped with the fuel cell (FC stack) 10 which generates power using the electrochemical reaction of hydrogen and oxygen. The FC stack 10 is constituted so that power may be supplied to electrical machinery and apparatus, such as the electric motor 11 for car transit (load), and a rechargeable battery which is not illustrated.
[0016] In the FC stack 10, the electrochemical reaction of the following hydrogen and oxygen occurs and electrical energy occurs.
(Negative-electrode side) The solid-state polyelectrolyte mold fuel cell is used as a FC stack 10, two or more laminatings of the cel used as a base unit are carried out, and it consists of H2 ->2H++2e-(positive-electrode side)2H++1/2O2+2e-->H2O operation gestalten. Each cel has the composition that the electrolyte membrane was inserted with the electrode of a pair. Moreover, the temperature sensor 12 for detecting the temperature of FC stack body is formed in the FC stack 10.
[0017] The air path 20 for supplying air (oxygen) to the oxygen pole (positive electrode) 10a side of the FC stack 10 and the hydrogen path 30 for supplying hydrogen to the hydrogen pole (negative electrode) 10b side of the FC stack 10 are formed in the fuel cell system. The blower 21 for air feeding for air supply (gas-compression machine) is formed in the air path 20. Hydrogen is supplied to the hydrogen path 30 from the hydrogen feeder 31.
[0018] It is necessary to make the electrolyte membrane in the FC stack 10 into the damp or wet condition containing moisture for the electrochemical reaction at the time of a generation of electrical energy. For this reason, at the time of operation, humidification is performed in the air of the air path 20, and the hydrogen of the hydrogen path 30 by the humidification equipment which is not illustrated, and the air and hydrogen which were humidified are usually supplied to the FC stack 10. By this, the FC stack 10 interior will operate by the damp or wet condition. Moreover, in the oxygen pole 10a side, moisture generates according to the above-mentioned electrochemical reaction.
[0019] Moreover, at the time of the below-mentioned moisture removal operation, the dry air which is not humidified and the desiccation hydrogen which is not humidified are supplied to the FC stack 10. In order for these dry gases to remove the moisture which remains in the FC stack 10, it needs to be desirable that it is low humidity as much as possible, and it needs to be low humidity from the humidity in the FC stack 10 at least.
[0020] The shut bulbs 22 and 23 for intercepting the air path 20 are formed in the both ends in the air path 20. The FC stack 10 and air path 20 interior can be intercepted from the open air by closing these shut bulbs 22 and 23. The same shut bulbs 32 and 33 are formed also in the both ends of the hydrogen path 30.
[0021] Moreover, the air path 20 and the hydrogen path 30 are connected in the upstream of the FC stack 10. The hydrogen path selector valve 35 is formed in the connection in the hydrogen path 30. changing the hydrogen path selector valve 35 -- usually -- at the time of operation, the hydrogen from the hydrogen feeder

31 can be passed for the hydrogen path 30, and the air from the air path 20 can be passed for the hydrogen path 30 at the time of a sink and moisture removal operation.
[0022] The moisture sensors 24 and 34 for detecting the residual moisture which exists in oxygen pole 10a of the FC stack 10 interior and hydrogen pole 10b are formed in the FC stack 10. With this operation gestalt, the humidity sensor is used as moisture sensors 24 and 34. In order to detect the humidity of the FC stack 10 interior appropriately, as for humidity sensors 24 and 34, it is desirable to prepare near [in oxygen pole 10a and hydrogen pole 10b] FC stack 10 outlet.
[0023] The FC stack 10 produces generation of heat with a generation of electrical energy. For this reason, cooling systems 40-45 are formed in the fuel cell system so that the FC stack 10 may be cooled and operating temperature may serve as optimal temperature (about 80 degrees C) at electrochemical reaction.
[0024] The cooling water path 40 which makes the FC stack 10 circulate through cooling water (heat carrier), Water pump 41 made to circulate through cooling water, and the radiator 42 equipped with the fan 43 are formed in the cooling system. The cooling section consists of a radiator 42 and a fan 43.
[0025] The heat generated in the FC stack 10 is discharged out of a system with a radiator 42 through cooling water. Such a cooling system can perform the amount control of cooling of the FC stack 10 by the air-flow rate control by the control of flow by Water pump 41, the radiator 42, and the fan 43.
[0026] Moreover, the heating unit (heating means) 44 for heating cooling water is formed in the cooling system of this operation gestalt in juxtaposition with the radiator 43. As a heating unit 43, an electric-type heater, a combustion heater, a catalyst heater, etc. can be used, for example. The amount control of heating of cooling water according to a heating unit 44 by such configuration and the control of flow by Water pump 41 can perform the amount control of heating of the FC stack 10.
[0027] The passage of cooling water is changed to a radiator 43 and heating unit 44 side by the cooling water selector valve 45. At the time of usual operation of the FC stack 10, the cooling water selector valve 45 is changed to a radiator 43 side, and the FC stack 10 is cooled. On the other hand, at the time of moisture removal operation of the FC stack 10 in this operation gestalt, the cooling water selector valve 45 is changed to a heating unit 44 side, and the FC stack 10 is heated.
[0028] The control section (ECU) 50 which performs various control is formed in the fuel cell system of this operation gestalt. The demand power signal from a load 11, the temperature signal from a temperature sensor 12, the residual moisture content signal from the moisture sensors 24 and 34, etc. are inputted into a control section 50. Moreover, the control section 50 is constituted so that a control signal may be outputted to a rechargeable battery, a blower 21, Water pump 41, the radiator fan 43, a heating unit 44, and cooling water selector-valve 45 grade.
[0029] Next, the moisture removal control in the fuel cell system of the above-mentioned configuration is explained based on drawing 2 . Drawing 2 is a flow chart which shows moisture removal control of a fuel cell system.
[0030] First, the moisture removal in the FC stack 10 (moisture purge) usually judges after shutdown whether it is the need (step S10). The judgment of whether to perform moisture removal is performed in consideration of environmental temperature (outside air temperature), seasonal information, etc. at the time of shutdown. That is, based on the said conditions with which environmental temperature is 0 degree C or less, or are winter etc., and the falls of atmospheric temperature are predicted to be, the judgment about the need for moisture removal operation is performed. Since there is no fear of freezing with a natural thing on conditions, such as summer, moisture operation is not needed.
[0031] Moreover, you may constitute so that the anticipation time amount of FC stack 10 stop time by the operator may be inputted at the time of the shutdown of the FC stack 10. This is because the FC stack 10 does not become [the preheating of the FC stack 10] below a freezing point enough in an instant for a certain reason but an elevated temperature is maintained for the time being, even if environmental temperature is below a freezing point at the time of a halt of the FC stack 10. Therefore, if it is in the stop time of about (one whole day and night) 10 hours, it is not necessary to perform residual water removal at the time of shutdown.
[0032] When judged with moisture removal operation being required at the above-mentioned step S10, the cooling water selector valve 45 is changed to a heating unit 44 side (step S11). By this, cooling water will be heated by the heating unit 44. In addition, since the FC stack 10 has already suspended the generation of electrical energy, cooling water selector-valve 45 grade operates by the electric power supply from a rechargeable battery.
[0033] Next, the hydrogen path selector valve 35 is changed to the air path 20 side (step S12), and ventilation control by the blower 21 is performed (step S13). Thereby, air is supplied to the air path 20 and

the hydrogen path 30. At this time, humidification is not carried out to air, but dry air is supplied to oxygen pole 10a of the FC stack 10, and hydrogen pole 10b. Thereby, the moisture which exists as a drop in the FC stack 10 is blown away by airstream besides the FC stack 10.
[0034] Next, the moisture sensors 24 and 34 detect the residual moisture content in the FC stack 10 (step S14), and it judges whether the residual moisture content is less than the freezing range fewer than the specified quantity (step S15).
[0035] When the residual moisture content in the FC stack 10 is less than the freezing range, the shut bulbs 22, 23, 32, and 33 prepared in the both ends of the air path 20 and the hydrogen path 30 are closed (step S16). Thereby, the FC stack 10, air path 20, and hydrogen path 30 interior is intercepted from the open air, and can prevent the moisture invasion from an external environment.
[0036] Consequently, when the residual moisture content in the FC stack 10 has exceeded the freezing range, FC stack temperature control of the following steps S17-S21 is performed, the FC stack 10 is heated, and evaporation removal of the residual moisture is carried out.
[0037] First, a temperature sensor 12 detects the temperature T of FC stack 10 body (step S17), and it judges whether FC stack temperature T has exceeded the target temperature Tr (step S18). The higher possible one of the target temperature Tr is desirable in order to evaporate the moisture in the FC stack 10. However, if the target temperature Tr is set not much as an elevated temperature, while causing physique increase of a heating unit 44, the electrolyte membrane of the FC stack 10 interior is destroyed. Therefore, in order to prevent such faults, the target temperature Tr is set as 80-100 degrees C.
[0038] When the amount of cooling water heating by the heating unit 44 is set as zero when FC stack temperature T has exceeded the target temperature Tr (step S19), and FC stack temperature T is less than target temperature, the amount of cooling water heating by the heating unit 44 is set as K (Tr-T) [K:proportionality constant] (step S20). Next, the circulating load of cooling water is controlled by Water pump 41 (step S21). Thereby, temperature control is carried out so that FC stack temperature T may turn into the target temperature Tr. It returns to the above-mentioned step S14 after the above temperature control.
[0039] The FC stack 10 interior can be maintained at an elevated temperature, without carrying out a temperature fall with moisture evaporation by performing FC stack temperature control of the above steps S17-S21. Thereby, evaporation of residual water is promoted in the FC stack 10 interior. The residual water which evaporated is discharged by the exterior of the FC stack 10 in the condition of having been contained in the air supplied from the air path 20 and the hydrogen path 30. Since dry air is supplied from the air path 20 and the hydrogen path 30 at this time, the inside of the FC stack 10 can be dried efficiently.
[0040] (Other operation gestalten) Although the humidity sensor was used in addition with the above-mentioned operation gestalt as moisture sensors 24 and 34 which detect the residual moisture content in the FC stack 10, the residual moisture content of the FC stack 10 interior is detectable not only this but by measuring change of the electric resistance of the electrolyte membrane in the FC stack 10 interior as for example, a moisture sensor.
[0041] Moreover, in each cel which constitutes the FC stack 10, moisture removal at least of the part should just be carried out. If a part of cel is dry, a generation of electrical energy can be started by supplying hydrogen and air to the desiccation part. If a generation of electrical energy is started in a part of cel, the temperature up of other parts can be carried out by generation of heat accompanying a generation of electrical energy, and it can generate electricity in the whole cel.
[0042] Moreover, although dry air was supplied from the air path 20 and the hydrogen path 30 at the time of moisture removal operation, you may constitute from an above-mentioned operation gestalt so that the gas of arbitration called not only this but nitrogen may be supplied.
[0043] Moreover, when it is beyond the temperature (for example, 150 degrees C) to which FC stack temperature T detected at the above-mentioned step S16 destroys an electrolyte membrane, the cooling water selector valve 45 may be changed to a radiator side, and you may constitute so that cooling water may be cooled positively and the FC stack 10 may be cooled.
[0044] Moreover, although the heating unit 44 which heats cooling water was formed in juxtaposition with the radiator 43 with the above-mentioned operation gestalt, not only in this but in the cooling water path 40, a heating unit 44 may be formed in serial with a radiator 43. In this case, what is necessary is to be the upstream of the branch point by the side of a heating unit 44 and a radiator, and just to move a heating unit 44 to the downstream of Water pump 41 in the fuel cell structure of a system of drawing 1 . In such a configuration, the path in which the heating unit 44 was formed turns into a bypass path for making a radiator 42 bypass in cooling water. The cooling water heated by passing a heating unit 44 by such

configuration in case moisture removal control after operation termination is usually performed passes through a bypass path, and bypasses a radiator 42.

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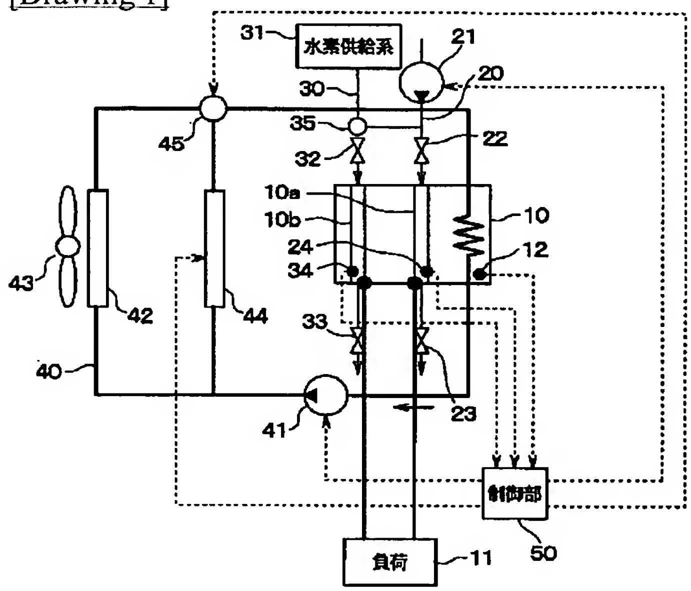
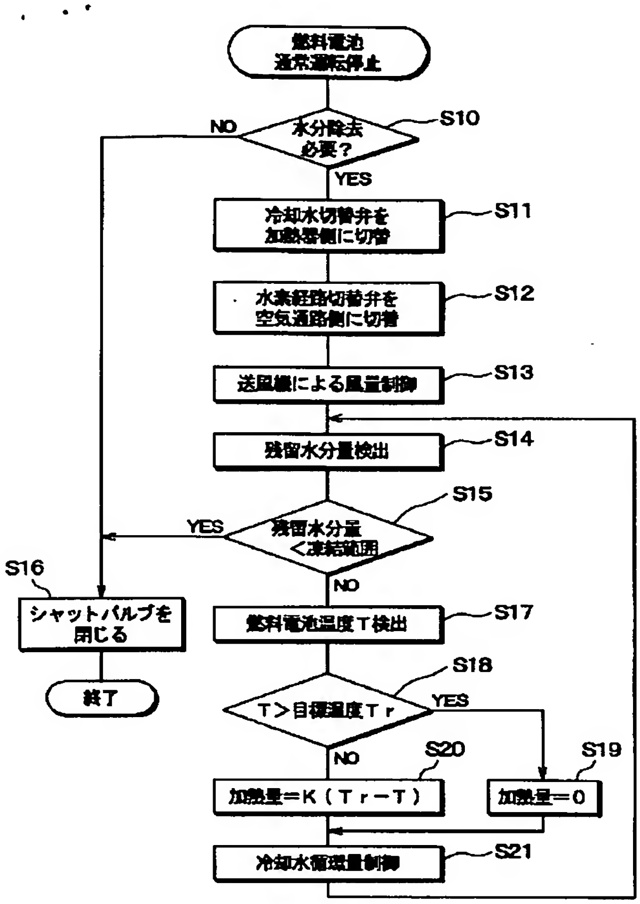
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

[Drawing 1]



[Drawing 2]



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